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Surgical Thrombectomy Followed by Intraoperative Endovascular Reconstruction for Symptomatic Ilio-femoral Venous Thrombosis

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Objectives. *To evaluate the efficacy of surgical thrombectomy combined with endovascular reconstruction for acute ilio-femoral/caval venous thrombosis.*
Methods. *Twenty consecutive patients with acute, symptomatic ilio-femoral/-caval thrombosis underwent valve-preserving thrombectomy with immediate endovascular repair between October 1996 and October 2003. Thrombectomy was classified by intraoperative venography as: TYPE I=complete, TYPE II=partial, TYPE III=complete with stenosis other than thrombus, TYPE IV=permanent occlusion. TYPEs I and IV were excluded from this analysis because endovascular repair was not performed.*
Results. *Left-sided venous thrombosis predominated (90%). Lesions were located in the common iliac vein (85%), the external iliac vein (10%), and the inferior vena cava (5%). Three TYPE II lesions and 17 TYPE III lesions (11 spurs, one hypoplasia, one fibrosis, one haematoma, and three others) were diagnosed. Catheter-directed recanalisation (thrombectomy/thrombolysis) resolved TYPE II lesions in three patients. Balloon angioplasty (one patient), iliac stenting (15 patients [two with thrombolysis]), and caval stenting (one patient) were employed in TYPE III stenoses. No serious complication or death occurred. Mean follow-up was 21 months. Of 20 patients clinical results were excellent in 18 patients who maintained patency of their reconstructed iliac veins. Primary and secondary patency rates were 80 and 90%, respectively.*
Conclusions. *Ilio-caval venous obstructions detected intraoperatively can be reconstructed in a one-stage combined procedure. The specific endovascular approach depends on the type of residual venous obstruction. Excellent mid-term results indicate that the proposed thrombectomy classification (TYPE I–IV) and treatment algorithm optimises the results in selected patients with symptomatic venous thrombosis.*

Keywords: Venous stenting; Deep venous thrombosis; Iliac stenosis; Caval stenosis.

Introduction

The standard recommended treatment for deep venous thrombosis in the lower limb is to use heparin anticoagulation in the initial phase. This is followed by compression therapy and oral anticoagulants.[1,2] The aim is to prevent propagation of thrombus and pulmonary embolism. Conservative treatment reduces acute mortality and morbidity as well as recurrent thrombosis.[1,2]

Surgical thrombectomy may be considered for acute symptomatic venous thrombosis of the leg extending into the iliac veins or vena cava (three- or four-level venous thrombosis). Thrombectomy may be appropriate in patients with isolated pelvic or caval thrombosis, floating thrombus, and pulmonary embolism, and in acute limb ischaemia (venous gangrene, phlegmasia cerulea dolens).[3–8] The aim of surgery is immediate relief of symptoms and prevention of chronic venous insufficiency. It is appropriate in certain clinical situations including young and active patients, in women during pregnancy and after delivery, in patients with traumatic or postoperative thrombosis.[3–5,8]

Long-term patency rates following surgical thrombectomy in the iliac veins range from 54 to 84% as assessed by phlebography.[9–12] Thrombosis recurs after thrombectomy or thrombectomy fails to achieve

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recanalisation in a proportion of patients.[13] Reocclusion after thrombectomy in patients with residual iliac or caval venous stenosis is reported to be as high as 72%.[13] Therefore, venous thrombectomy needs to be followed by routine intraoperative angiography or alternative investigations (angioscopy or endovascular ultrasound) to detect which patients are at risk of developing recurrent occlusive thrombus.[13–15] Where residual obstruction is detected endovascular reconstruction (stenting, angioplasty or catheter-guided recanalisation) should be urgently considered. Few published studies report the outcome of combined surgical thrombectomy and intraoperative endovascular venous reconstruction.[13,16–19] We have been performing venous thrombectomy with intraoperative completion phlebography and subsequent endovascular reconstruction as a combined one-stage procedure since October 1996 at our institution and report our consecutive clinical series.

Methods

Selection of patients

Patients in whom venous thrombectomy was performed and who were additionally treated by intraoperative endovascular techniques (catheter-controlled recanalisation or lysis, angioplasty, with or without stent deployment) between October 1996 and October 2003 are reported in this clinical series. The indications for surgical thrombectomy were deep venous thrombosis of the lower extremity extending into the iliac veins or the vena cava demonstrated by colour duplex sonography, MR/CT imaging or phlebography. Patients with a history of malignancy were treated only if they were at risk of imminent limb loss (phlegmasia cerulea dolens or venous gangrene) or had treatable disease. Surgical intervention was only considered for patients in whom the onset of clinical symptoms of the deep venous thrombosis (clinical thrombus age) was less than 7 days.

Classification of venous ilio-caval stenosis

The results of surgical thrombectomy was assessed intraoperatively by ascending phlebography. Surgical thrombectomy clearing all thrombotic material was defined as TYPE I. Residual thrombotic stenosis or occlusion after surgical thrombectomy was referred to as TYPE II. Venous wall obstructions other than residual thrombus (e.g. spur, web, hypoplasia, infiltration and compression) were defined as TYPE III. Permanent venous occlusions of the ilio-femoral junction with impairment of the venous inflow were defined as TYPE IV.

One-stage endovascular procedure

Thrombotic material from below the inguinal ligament was evacuated via an incision in the femoral vein. We used a valve-preserving technique involving manual compression of the leg augmented by elastic bandages [under 15 mmHg PEEP ventilation (positive end expiratory pressure) and 30° chest elevation]. We avoided retrograde insertion of a balloon catheter to preserve valve function in the axial veins of the lower limb.[20] Venous thrombectomy in the iliac veins and IVC was performed with a balloon catheter and tactile feedback during withdrawal of thrombus gave the first indication of residual iliac or caval stenosis.[20,21] Ascending phlebography was then performed in all patients to assess the iliac veins.[14,15] If residual venous obstruction was detected an appropriate endovascular treatment was chosen, depending on the location, morphology, and nature of the lesion. Wire-guided thrombectomy alone or in conjunction with local thrombolysis were used to manage residual thrombotic venous stenosis (TYPE II). Local thrombolysis was carried out using a pulse-spray catheter (multi-side-hole) to inject urokinase (250,000–500,000 IU). Venous hypoplasia, a web or spur causing central venous outflow obstruction (TYPE III) was treated by stent deployment. Stents were placed using an introducer sheath guided through the venotomy and administered using a Terumo® guide-wire under the guidance of a mobile digital subtraction angiography unit. When positioning the stent in the iliac vein, care was taken not to occlude the internal iliac vein or the contralateral common iliac vein with the device extending into the inferior vena cava. Temporary arterio-venous fistulas were not routinely fashioned. Perioperatively anticoagulation was achieved using a full-dose regimen with intravenous unfractionated heparin. After discharge from the hospital, patients usually received oral anticoagulation (phenprocoumon) for 6–12 months and testing for thrombophilic disorders was advised. The duration of oral anticoagulation was determined for each patient individually in cooperation with a medical specialist in thrombophilic diseases.

Study population

Forty consecutive patients underwent surgery for iliofemoral/-caval thrombosis. Ten patients had a patent

ilio-caval system after central thrombectomy using a Forgarty catheter (TYPE I thrombectomy). Four patients with thrombotic venous obstruction were found to be unreconstructable (TYPE IV) because of phlegmasia, venous interruption with consecutive descending thrombosis, or occlusion of the iliofemoral junction without sufficient venous influx. Six patients were treated by open thrombectomy of the iliac system. For the purpose of this analysis patients presenting with TYPEs I and IV lesions and patients receiving open thrombectomy were excluded. These patients were not included in our further clinical series because there was no indication to perform angioplasty or to place a stent.

Twenty patients (17 female patients and three male patients; mean age, 37 years) underwent thrombectomy and were found to have residual stenoses of TYPE II and III. Additional endovascular reconstruction was required in these patients. Ten of these patients (50%) had suffered venous thrombosis after immobilisation [postoperatively ($n=6$), economy class syndrome ($n=2$), fracture ($n=1$) and delivery ($n=1$)]. Seven patients (35%) had a thrombophilic disorder [factor-V-Leiden mutation ($n=2$), protein-C deficiency ($n=1$), prothrombin gene mutation ($n=2$), heparin-induced thrombocytopaenia ($n=1$) and homocysteinaemia ($n=1$)]. Benign tumours were diagnosed in four patients (20%) (one pancreatic tumour, one cystic adenoma of the ovary, and two patients with myomatous enlargement of the uterus). One patient was suffering from an advanced bladder carcinoma and required surgical treatment for venous phlegmasia. Another male patient had a history of curative surgery and adjuvant radio- and chemotherapy for rectal cancer. Prostatic cancer with bone metastasis was detected postoperatively in one other patient. Primary venous thrombosis was diagnosed in 75% of the patients, 25% with recurrent acute deep venous thrombosis.

Follow-up

Patients were seen regularly during the observation period in our outpatient clinic. The standard follow-up was at 6 weeks and 6 months postoperatively and yearly, thereafter. Patients were asked about symptoms suggesting thrombotic recurrence, including pain and discomfort. Patients were categorised according to their CEAP clinical stage following clinical examination. We assessed swelling (measurement) and visible venous disease including the presence of reticular veins, varicose veins, ulceration and skin changes. Clinical examinations were usually combined with colour duplex sonography in order to evaluate the patency of the venous reconstruction. Further phlebography or MR angiography was not performed to assess the outcome of treatment since we considered duplex ultrasonography sufficient to assess the patency of the iliac veins.

Results

Concomitant venous obstruction

Left-sided venous thrombosis predominated (90%). Obstruction of the common iliac vein was observed in 17 of 20 patients (85%). Stenosis of the common iliac vein was caused by residual thrombotic material (TYPE II) in three patients (15%). Stenosis of the common iliac vein was caused by a spur or web in 11 patients (55%) (TYPE III). One patient presented with a fibrotic stenosis of the common iliac vein 3 years after surgery and radiotherapy for curative treatment of a rectal carcinoma (5%). A compressive obstruction of the common iliac vein was caused by a prevertebral haematoma after an orthopaedic operation to the spine and in a further case by local spread of a bladder tumour (patient with imminent venous gangrene) (10%). Two patients were diagnosed with segmental stenosis of the external iliac vein (10%) and one patient with hypoplasia of the inferior vena cava (5%) (Table 1).

Table 1. Summary of the lesions identified in our series of 20 patients treated by combined surgical thrombectomy and endovascular interventions

• Obstruction of the common iliac vein	
• Stenosis by spur or web	11
• Radiogenic/fibrotic stenosis	1
• Residual thrombotic stenosis	3
• Compressive prevertebral hematoma	1
• Compressive bladder carcinoma	1
• Obstruction of the external iliac vein	
• Segmental stenosis	2
• Obstruction of the inferior vena cava	
• Hypoplasia	1

Endovascular venous reconstruction

Endovascular repair of the venous obstructions depended on the type and localisation of the stenosis. Three patients with residual thrombus (TYPE II) in the common iliac vein were treated by Terumo®-guided thrombectomy alone ($n=1$) or in combination with local thrombolysis ($n=2$) (Fig. 1). Segmental stenoses of the common iliac vein caused by venous spurs or

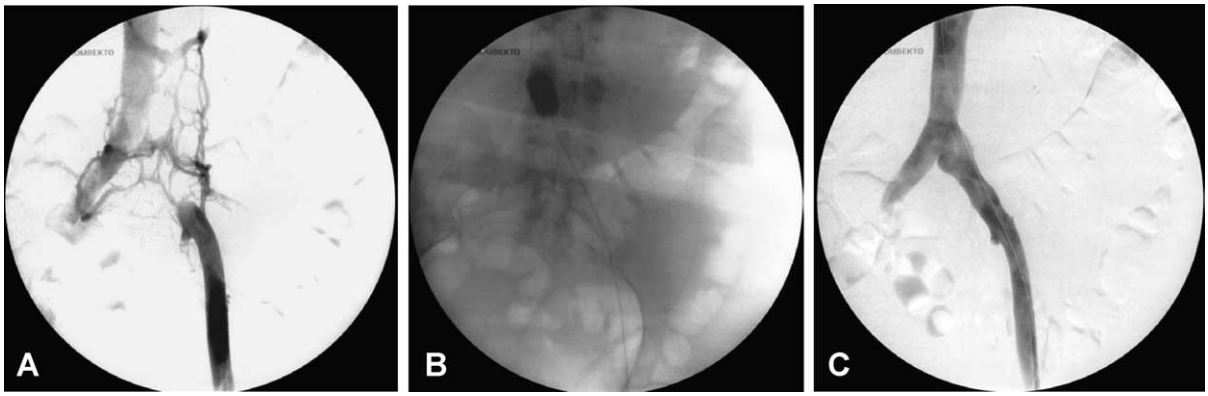


Fig. 1. A 43-year-old woman with MEN syndrome suffered an ilio-femoral thrombosis 3 days after pancreatic resection. After clearing fresh thrombotic material venography showed residual thrombotic occlusion of the common iliac vein with collateral venous drainage (TYPE II thrombectomy) (**A**). Using a Terumo® guide wire the thrombus was passed under radiographic control (**B**) and completely extracted by a wire-guided balloon catheter (**C**). Oral anticoagulation was continued for 6 months. Duplex ultrasonography showed that the iliac veins were patent 23 months later.

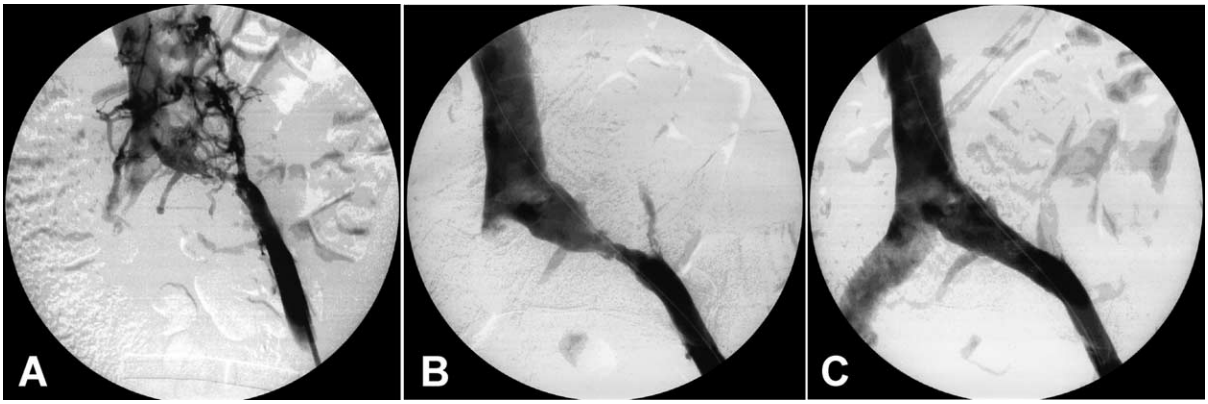


Fig. 2. A 36-year-old woman with thrombosis extending from the thigh to the inferior vena cava 10 days after delivery. Primary transfemoral central thrombectomy was complicated by rethrombosis. Following re-thrombectomy venography showed an occlusion of the common iliac vein with collateral drainage (TYPE II thrombectomy) (**A**). Terumo®-guided thrombectomy (TYPE III thrombectomy) was combined with deployment of a Smart® stent to treat an iliac spur (**B**). After stenting the iliac veins were patent (**C**). Postoperatively a heparin-induced thrombocytopenia type II was diagnosed. Clinical symptoms resolved and the reconstruction was patent 3 months postoperatively.

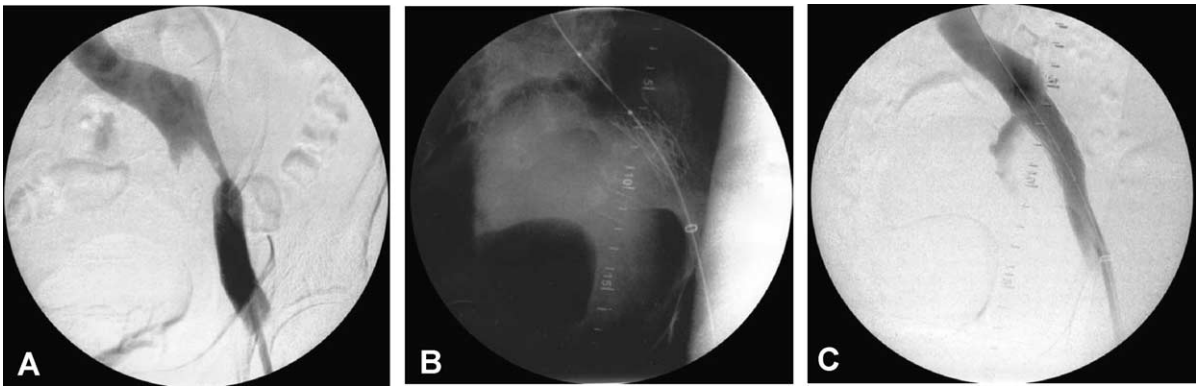


Fig. 3. A 62-year-old man underwent transfemoral thrombectomy with subsequent ascending venography. The venous angiogram shows a stenosis of the external iliac vein (TYPE III thrombectomy) (**A**). The stenosis was treated by deployment of a Palmaz XXL® stent (**B**) and the reconstruction was patent on completion phlebography (**C**). Fifteen months after treatment the reconstruction was patent and the patient was free of swelling and pain.

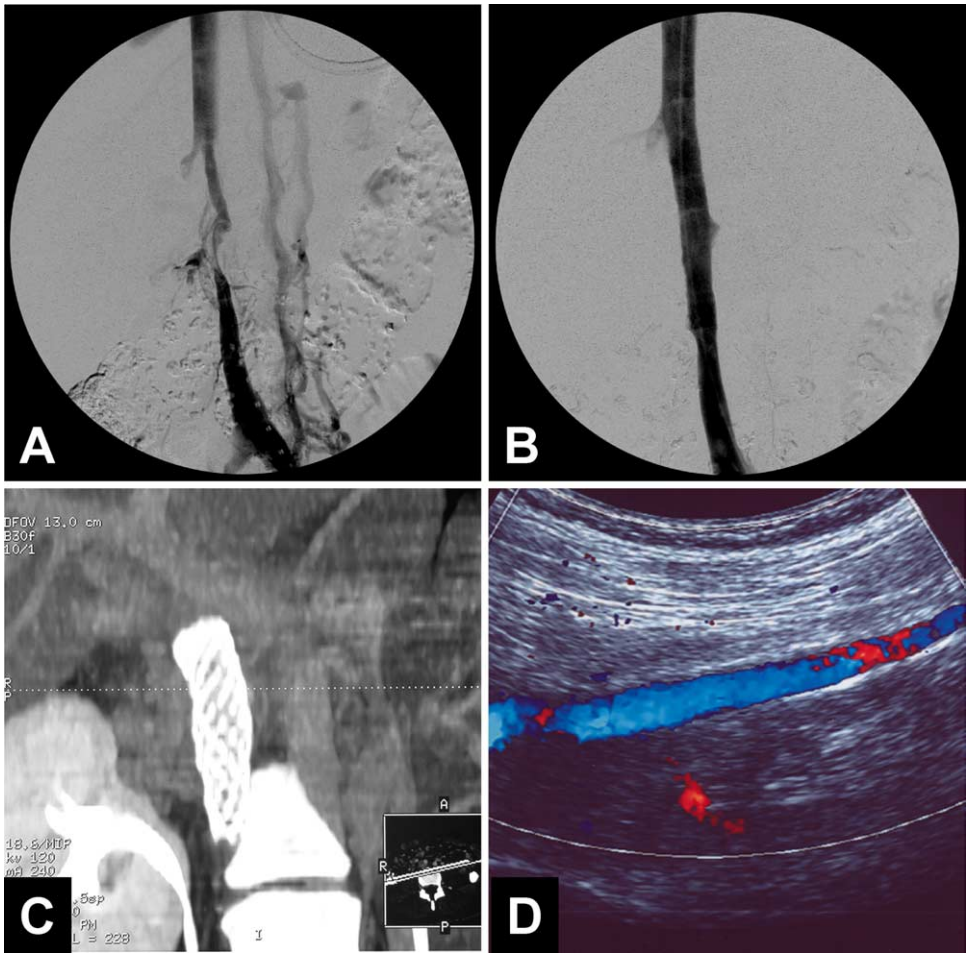


Fig. 4. A 16-year-old female patient underwent transfemoral thrombectomy with subsequent ascending venography. The venous angiogram showed segmental hypoplasia of the inferior vena cava (**A**) with collateral venous drainage (TYPE III). The caval stenosis was treated by deployment of a Corinthian® stent resulting a patent IVC (**B**). One year after treatment the patient was completely free of discomfort, swelling, and pain. Follow-up CT imaging showed the stent location (**C**) and ultrasound confirmed a patent ilio-caval venous system (**D**).

radiogenic fibrosis was treated by stent deployment (13 patients with two patients receiving intraoperative local thrombolysis) (TYPE III) (Fig. 2). Segmental stenosis in the proximal region of the external iliac vein was treated by balloon dilatation (one patient) and by stenting (one patient) (Fig. 3). A 16-year-old girl with a bilateral symptomatic thrombosis with massive limb oedema and pain had caval hypoplasia and was treated by stent deployment to the inferior vena cava (Fig. 4). Two patients were treated by percutaneous stent deployment. A total of 20 venous stents were placed in the iliac veins. Balloon-expanded Palmaz® XXL stents (Cordis, Johnson and Johnson, USA) were used to treat nine patients (12 stents). Self-expanding Easy-Wallstent® endoprotheses (Boston Scientific, USA) were used in four patients (six devices). The Wallstents® required dilatation after insertion because of incomplete opening due to the fibrotic nature of pelvic spurs. Three patients were treated either with a Symphony® or a Smart stent® (Cordis, Johnson and Johnson, USA). One Corinthian® stent (Cordis, Johnson and Johnson, USA) was deployed to treat the stenosis of the inferior vena cava. Five of 16 patients required placement of two stent devices. The stent diameter in the common iliac vein was either 14 or 16 mm and the length 40 or 50 mm. Only one patient with radiogenic stenosis of the common iliac vein was treated by a stent of 12 mm in diameter.

Feasibility and complications

Endovascular reconstruction was accomplished in all patients without specific complications. One stent (Palmaz XXL®) was dislodged into the inferior vena cava by the introducer sheath during deployment of a

second stent. This was corrected by retraction and repositioning with a balloon catheter. The local morbidity (10%) consisted of one lymphatic fistula and one seroma. No patient suffered clinically apparent pulmonary embolism. No death occurred due to surgery.

Clinical outcome

The mean follow-up was 21 months (range, 0.5–77 months). Two patients died during the follow-up period. At the most recent assessment the clinical outcome was as follows:

CEAP clinical stage

C0a: 13 patients (no visible venous disease, asymptomatic),
C1a: one patient (telangiectases and reticular veins),
C3a: four patients (oedema, asymptomatic), and
C3s: two patients (oedema, symptomatic with pain).

Limb pain and clinically apparent swelling was always associated with reocclusion of the iliac venous outflow tract.

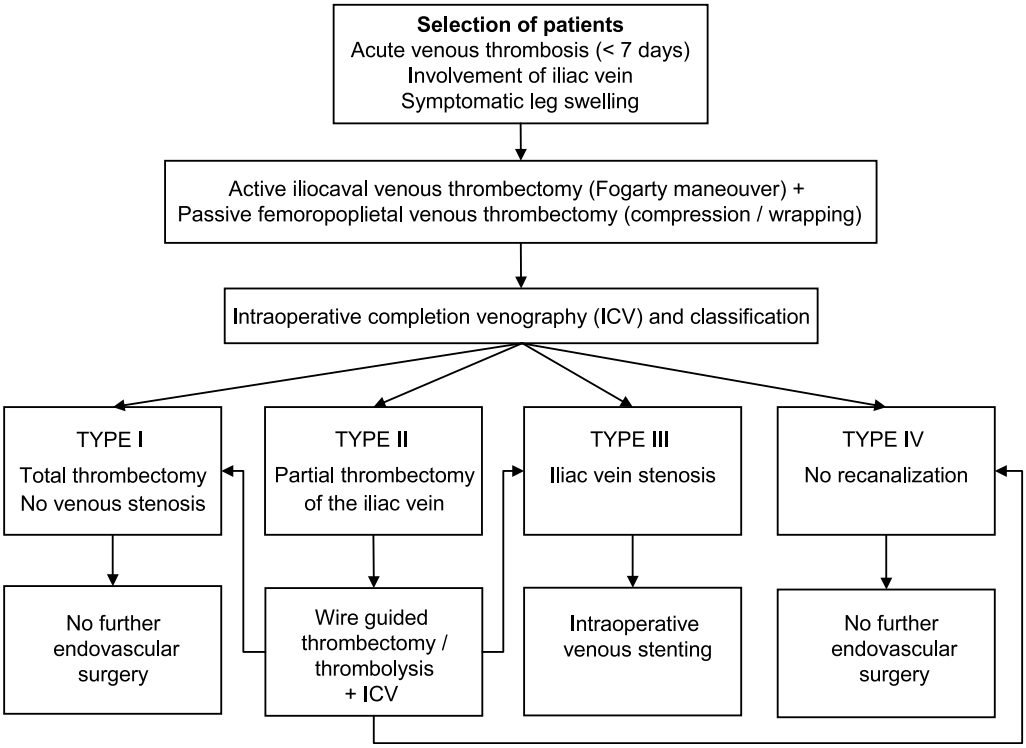
The primary patency rate of the central venous reconstructions was 80% (16 of 20 patients). The secondary patency rate was 90% (18 of 20 patients). One early rethrombosis occurred in a 33-year-old woman 10 days after thrombectomy and iliac stenting (two Palmaz® XXL stents) during the start of oral anticoagulation. This patient had a postoperative deep venous thrombosis of the iliac vein extending into the vena cava associated with prothrombin gene mutation. The rethrombosis was treated by intravenous unfractionated heparin and resolved completely as documented by CT scanning and duplex ultrasonography. Oral anticoagulation was continued for 1 year. Clinically the patient presented without significant swelling, pain and discomfort during follow-up. The second early rethrombosis was observed in a 32-year-old woman with a cauda equina syndrome 3 days after iliac stenting. A postoperative prevertebral haematoma after lumbar decompression caused thrombosis as a result of compression of the external and common iliac veins. The endovascular treatment consisted of thrombolysis and deployment of two Wallstents® for the extended venous stenosis. Under conservative treatment (compression and oral anticoagulation) the iliac vein recanalised with minor clinical symptoms (moderate swelling). Two patients experienced persistent rethrombosis of the iliac venous tract with development of a collateral venous circulation and significant clinical symptoms. One of these patients, a 47-year-old woman experienced rethrombosis after incomplete recanalisation of the common iliac vein by thrombectomy and additional catheter-directed thrombolysis documented on completion venography. Oral anticoagulation and compression therapy were continued but an occluded iliac venous outflow tract was diagnosed 6 months postoperatively. Another 31-year-old woman who was treated for a third occurrence of a venous thrombosis and multiple episodes of pulmonary embolism experienced rethrombosis of the iliac veins 6 months after iliac stenting. A concomitant protein C deficiency was diagnosed. The last two patients experienced persistent swelling and pain in the affected limb.

Discussion

The outcome of venous thrombectomy depends on whether iliac or caval obstruction is present as the cause of the original thrombosis. A number of mechanisms have been proposed. Valve-like strictures of the left iliac vein causing ilio-femoral venous thrombosis have been described.[22,23] In 1956, May and Thurner hypothesised that the pulsation of the overlying right common iliac artery might induce reactive cell proliferation in the venous wall of the left iliac vein, giving rise to venous stenosis (web or spur).[24] The frequency of venous spurs in the left iliac vein has been evaluated in autopsy studies and is reported to be about 20%.[25] In our series iliac stenoses were also caused by a prevertebral haematoma, retroperitoneal radiogenic fibrosis and tumour spread. A recent analysis showed that 30 of 61 patients (49%) with left-sided deep venous thrombosis presented with a common iliac venous obstruction suggestive of venous spurs.[13] In the latter study, 16 of a total of 22 patients (73%) with such iliac venous obstructions developed another thrombosis after venous thrombectomy without immediate stenting although anticoagulants were administered.

A number of surgical techniques have been advocated to address venous spurs. Among these are sapheno-femoral or ilio-iliac crossover bypasses, arterial repositioning, peritoneal flap, fascia lata sling, prosthetic bridging, and aortic elevation.[13] Modern endovascular techniques allow minimally invasive reconstruction of the ilio-caval venous system. Following thrombectomy any residual stenosis in this region can be addressed by balloon angioplasty and stenting.[13,16–19] After central venous thrombectomy using Fogarty catheters an ascending venography can be used to detect such residual stenoses.[14,15,21] We prefer wire-guided thrombectomy as the endovascular procedure

Table 2. The authors' algorithm for the use of intraoperative endovascular reconstruction of the ilio-caval thrombosis included a proposed classification system for lesions in this region



for residual thrombus. Adherent thrombi may also require additional catheter-guided thrombolysis. Iliac webs or spurs are effectively resolved by intraoperative endovascular stenting or dilatation.[13,16–19]

We have suggested above a four stage classification which describes the outcome of surgical thrombectomy as assessed by completion venography.[15,16] Those patients with a TYPE I outcome (complete recanalisation) require no additional treatment. Patients with residual thrombus (TYPE II) benefit from catheter thrombectomy combined in some cases with thrombolysis. Those with a TYPE III outcome will benefit from dilatation and stenting of the residual stenosis. Patients with a permanent occlusion of the iliofemoral axis (venous interruption by trauma or other causes or previous thrombotic occlusion) combined with an insufficient venous inflow (TYPE IV) will not benefit from intraoperative intervention of this type. Half of our series belonged to TYPEs I and IV and therefore, did not require additional treatment to the iliac veins. We have summarised our algorithm in Table 2.

In this study, additional endovascular reconstruction was performed without serious complication. No patient suffered clinically apparent pulmonary embolism nor was any hospital mortality encountered despite the fact that temporary caval protection devices (filters) were not routinely used, as has been suggested by others.[26–29] The primary and secondary success rates of thrombectomy combined with endovascular surgery were 80 and 90%, respectively. The clinical outcome during the follow-up period was excellent, although we acknowledge that this is based on limited numbers. Our analysis was based on observation of a clinical series assessed only by duplex ultrasonography which we acknowledge may provide less information than follow-up phlebography. However, we have reported a larger group than previous publications in this field. (Table 3). Mickley *et al.* observed a patency rate of 87% in eight patients with acute ilio-femoral thrombosis after thrombectomy and stenting.[13] Respectable results were found in six patients treated intraoperatively by stenting and AV-fistulas during a follow-up period of 23.5 months.[16] Apart from two case studies about intraoperative endovascular venous reconstruction, another group described the treatment of four patients after surgical thrombectomy and percutaneous endovascular reconstruction with patent reconstructions in all cases.[17–19] In another series, satisfactory long-term success rates have been described after surgical thrombectomy,

Table 3. Published clinical series using transfemoral surgical thrombectomy and intraoperative endovascular venous angioplasty in patients with acute ilio-caval venous thrombosis

Author	Year	Number of patients	Procedure	Follow-up (months)	Results
Juhan *et al*.[16]	2001	6	Thrombectomy, Stent placement, AV-fistula	23,5	Good results
Mickley *et al*.[13]	1998	8	Thrombectomy, stent placement		82% Patent
Rosenthal *et al*.[17]	1998	1	Thrombectomy, stent placement, AV-fistula	16	Patent
Lacroix *et al*.[18]	1998	1	Thrombectomy, stent placement	24	Patent
Binkert *et al*.[19]	1998	4	Thrombectomy, stent placement*	36	All patent

* Endovascular reconstruction was performed postoperatively.

angioscopy and selective stenting for benign venous stenosis in the pelvis.[30]

In contrast to these small series, interventional percutaneuos catheter-directed thrombolysis and selective stenting was evaluated in a study from a multi-centre registry.[31] In the latter analysis a substantial number of major bleeding complications and a low percentage of complete recanalisations was observed.[32,33] This series included patients with chronic obstruction of the iliocaval-veins which may be less suitable for endovascular repair. Several clinical trials have shown that balloon angioplasty and stent insertion for non-malignant venous ilio-caval obstruction is a promising technique.[34–38] Our clinical data suggest that prospective clinical trials should be undertaken to address the question of the beneficial effects of thrombectomy combined with endovascular reconstruction in selected patients with acute symptomatic deep venous thrombosis.

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